
SEA MUSSELS AND DOGFISH AS FOOD



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Paper presented before the Fourth International Fishery Congress
held at Washington, U. S. A., September 22 to 26, 1908

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Of the two sources of human food, the possibilities of the land have been extensively studied while those of the ocean have been greatly neglected. Only a few observations are necessary to show how in ignorance and prejudice we have been overlooking and rejecting enormous quantities of valuable food material which are daily going to waste. With our rapidly increasing population the capacity of the soil to produce enough food is gradually approaching its limit. The resources of the sea, on the other hand, are practically unlimited. It is there our opportunities lie for meeting the increased demand for food which can be supplied at prices suitable to the laboring man's purse.

For the past three summers I have been employed by the Bureau of Fisheries to investigate the food value of certain hitherto unused marine animals. Of the forms studied I wish to speak to-day concerning the sea mussel and the smooth and the horned dogfishes.

A food substance to be considered a good marketable commodity must measure up well to four standards: It must be palatable, digestible, nutritious, and so abundant that it can be marketed at little cost.

To determine the palatability of the substances I was concerned with, the obvious method was for me to eat the substance and if no ill results followed persuade others to eat it, then average opinions in regard to it. The scientific staff of the Woods Hole Laboratory gave me first opinions in these tests. If they found the flavor good, I had the dish served on mess tables of the Marine Biological Laboratory at Woods Hole and to other persons interested enough to try it.

The second test, digestibility, involves several requirements—namely, the proportion of the substance that can be digested, the ease or rapidity with which it can be digested, and the manner in which the food is accepted by the stomach. Comparatively little is known concerning the relative rapidity of digestion of different foods within the body. Most of the current statements on the

subject are apparently based on experiments made outside of the body by artificial methods, imitating as closely as possible the conditions in the body, but not at all certain to be exactly the same. The artificial process takes much longer than the natural, yet proportionally the results are similar. For example, under natural conditions soft-boiled eggs will digest more quickly than hard-boiled ones. By the artificial method the process takes twice the time for each, but about the same proportionate results are obtained.

The third requisite, nutritive value, involves such questions as the ratio of edible portion to refuse, together with the chemical composition. A good food must supply for the least money a proper amount of nutrients to build and repair tissue and furnish energy for the body.

In the fourth place, the food must be so abundant and easily obtained that it can be sold reasonably cheap.

Any hitherto unused substance that measures up well to these standards ought to find its way into our regular bill of fare.

THE COMMON SEA MUSSEL.

Now the common sea mussel, *Mytilus edulis*, is one of our most common shellfish, in size varying from 2 to 4 inches long by about 1½ inches in diameter. The shell is very thin, of a violet color, and covered with an epidermis of shining blue-black. Mussels grow in great beds along both our Atlantic and Pacific coasts, and on the coasts of Europe and Asia.

Very little use is made of the mussel in this country, it being utilized only as bait to some extent and on Long Island for fertilizer. In Europe it entirely replaces as a food the common clam, which, though abundant, is used neither for bait nor food. Why the mussel is so neglected in America Ganong lays to the fact that the Indians superstitiously avoided it, while they ate the clam, thus leading the early white settlers to do the same thing, a habit that has been continued to this day. Only in and about New York City do we find a call for mussels as food, and this is limited.

From the standpoint of palatability I have unanimous testimony from scores of persons who have eaten mussels prepared in various ways—pickled, steamed, roasted, and fried. All acknowledged that in flavor they are superior to clams and quite equal to the oyster. I have unsought testimony from a lady who, with her daughter, spent a season on the Rhode Island coast and there learned to eat the mussel. She says:

Two years ago we boarded a little while at Matunuck, R. I., 3 miles west from Point Judith. There are large mussel beds there, and we were told that they were particularly nourishing for people of weak digestion. My daughter was very fond of them. We boiled them like clams or roasted them on hot stones and found them most delicious, particularly when roasted. We ate quarts every day and have longed for them ever since. My daughter gained strength while there, and it was the only time that she seemed to gain during the summer.

From the standpoint of digestibility the mussels take high rank. Persons with weak stomachs can eat them without suffering any inconvenience. They can be eaten before going to bed and cause no discomfort. One of the men at the Woods Hole Laboratory who became very fond of them expressed his opinion that the pickled variety was just the thing to eat before retiring. Another man says that while meat does not ordinarily agree with him he can partake freely of mussels and feel perfectly well. Personal experience on the part of many testifies that the mussel is more digestible than either the oyster or the clam. The reason for this, I believe, is in the character and properties of the flesh, which by cooking is made tender and mealy, whereas in the oyster and clam it becomes very tough.

The rate of digestion and amount of nutriment absorbed from the mussel by the human system have not yet been determined. The nutritive value from a chemical standpoint is much higher than that of the oyster and about the same as that of the clam. In ratio of edible portion to refuse, the mussel compares just as favorably with the oyster and clam. With its light shell it has little waste, whereas the oyster with its thick, heavy shell has a high percentage of useless parts. From equal quantities of mussels and oysters by weight the mussels will yield between two and three times as much meat.

From the standpoint of economy, mussels rank equally high. They are widely distributed and extremely abundant, being found in the bays and estuaries of our eastern coast from North Carolina northward and on our Pacific coast from Alaska to San Francisco. They grow in great beds, often acres in extent, on the surface of mud or sand at low-tide mark. They also grow in the deeper water, where they may be dredged up by the ton. I am informed that there are places in Narragansett Bay where a man could easily obtain 50 bushels a day throughout the whole season from May to November, if he had a partner to take and dispose of the catch, and it is considered that 35 cents a bushel would be a reasonable price to ask for them under these circumstances. The mussels breed at a prolific rate, the method of reproduction being similar to that of the oyster, so that it is an easy matter to cultivate them by artificial means.

In Europe the demand for mussels as food and bait is so great that mussel culture is practiced on a large scale. Two methods of cultivation are followed, one of which may be termed the "buchot" system or French method, and the other the bed system or British method. The French method of cultivation dates back to the year 1035. It was invented by an Irishman named Walton, who was the sole survivor from a shipwreck in the Bay of Aiguillon near the village of Esnandes. He was kindly received by the French fishermen, who, up to that time, had been able to make a very scanty living from the sea. In a short time he was able by his ingenuity to give them a lasting reward by establishing the buchot method of mussel culture, which has continued to this day and at the present

time gives support to several thousand inhabitants of that region. In 1905 the village of Esnandes alone marketed 215,253 bushels of mussels, valued at \$112,433. The total number of mussels cultivated on the French coast in 1905 is estimated at 425,492 bushels, valued at \$222,439.

Walton's buchots, or wooden inclosures, for the rearing of mussels were made V-shaped, with the apex pointing out to the sea, the purpose of the arrangement being to protect the structure from the destructive action of the winds, waves, and ice. At the present time a buchot is made up of a row of stakes placed about 2 feet apart and interlaced with a mesh work of flexible willow or chestnut branches some 12 to 18 feet long and 2 inches in diameter at the larger end. The stakes are trunks of trees varying from 6 inches to 1 foot in diameter and from 12 to 15 feet in length, and are driven into the ground for about one-half their length. The length of a buchot at any particular place varies with the character of the bottom and the tides. In the Bay of Aiguillon they are 250 yards long and placed about 30 yards apart, running at right angles to the shore. The buchots are arranged in two divisions, one for collecting the spat, the other for the growth and fattening of the mussels. The two divisions may be composed of as many as five buchots, extending from between tide marks out into deep water. The structures out in the deep water may be as much as 3 miles from high-water mark and are exposed only at the lowest tides. They are composed merely of solitary stakes placed about 1 foot apart, which serve for collecting the spat and forming a most advantageous position for its early growth.

When about 5 months old the seed mussels are scraped off the piles and transferred to the next buchot nearer the shore, where they are fastened in parcels by means of old netting. By the time the netting has rotted away the mussels are firmly attached to the timbers by their byssal threads. When they have grown so large as to be crowded on the wicker work they are thinned out by removing the larger ones to the next higher buchots, and so on from one section to the other, each time transferring the mussels to the buchots nearer the shore. The mussels are attached by the same operation already described, but are not wrapped so carefully, since their size is such as to enable them to be more securely fastened without help of the netting. The work of transferring mussels goes on day and night whenever low tide permits.

After about one year's treatment upon these structures the mussels attain marketable size, which is between $1\frac{3}{4}$ and 2 inches in length. Before ready to be offered for sale, those that have reached the desired size are transplanted to the highest row, where although left dry twice each day they thrive well and can be easily handled when desired for market. Having become inured to exposure upon these upper rows, these mussels consequently keep longer and fresher than those from the lower rows. The poorest cultivated mussels are considered better than the best mussels grown under natural conditions.

The British method of mussel culture, briefly, is to collect young mussels from various places and transfer them to beds in favorable localities, usually in estuaries, where the water is brackish and where they are exposed at low tide, both of which conditions are supposed to favor growth and fattening. It has been estimated that the average yearly yield of an acre of such mussel beds is 108 tons, worth at least \$262, which is about ten times as much as the agriculturist expects from his farm.

To summarize the qualities of the mussel, we have a shellfish as palatable as the oyster, much more nutritious, and more digestible. It contains only half as much waste as the oyster, is more abundant, is more easily cultivated in that it requires less special conditions for growth, and it is adapted for making a greater variety of food preparations. Furthermore, it is in season for the table when the oyster is out of season.

THE SMOOTH AND HORNED DOGFISHES.

The smooth and the horned dogfishes constitute another article of food that prejudice is keeping from our tables. Of these I will merely state the results of my investigations. The smooth dogfish is common on our eastern coast south of Cape Cod during the summer, and, as I have shown in a recent paper, is a most destructive enemy of the lobster. The horned dogfish during the summer months has its range north of Cape Cod, where it is exceedingly abundant, and during this season plays havoc with the herring, the mackerel, and other fishing operations. This species, although it has a general resemblance to the smooth dogfish, is easily distinguished by the two horns, one lying in front of each dorsal fin. The habits, composition, and food properties of the two species are very different.

The smooth dogfish is a bottom feeder, preying almost entirely upon crabs, lobsters, and other crustaceans. It does not run in schools, as does the horned dogfish, which goes in enormous numbers, preying upon the large schools of herring, mackerel, and upon fish caught on the trawler's line.

In composition the flesh of the smooth dogfish is free from oil, resembling most closely the cod. The horned dogfish, on the other hand, contains a large percentage of oil and in this respect most closely resembles the salmon.

From the standpoint of palatability I have good testimony that the fresh smooth dogfish is just as good as flounder, halibut, or any other of the standard food fishes. I have had the fish served several times in various ways at the mess of the Marine Biological Laboratory, at one of the private boarding houses in Woods Hole, Mass., and in a number of private homes. In all cases, whether or not the persons knew what they were eating, favorable comments were made as to the texture and flavor of the fish. Not one adverse criticism was heard. Concerning the flavor of freshly prepared horned dogfish I can not speak from

personal experience, but there is abundant testimony that it is good. The Commissioners on Fisheries and Game of Massachusetts have personally reported its palatability, the lack of odor or "strength," and the good consistency when cooked or canned. They say it closely resembles halibut. The horned dogfish has in recent years been exploited in England as a valuable cheap food. A writer in a London paper states that the Plymouth council engaged an expert cook to prepare dogfish for the table with and without sauce, and that the published opinions of those who partook were excellent as to the color, flavor, and firmness of the food. Both species are nutritious and boneless and are therefore a safe food for both the young and the aged.

The dogfishes are not only palatable in the fresh condition, but are as good as many other fishes when preserved by the standard methods. The horned dogfish being in composition most like the salmon is best adapted for canning and is considered as good as the medium grades of salmon. A packer in Petit de Grat, Cape Breton, in 1904 sent me a dozen cans of dogfish he had packed. I passed them around to my friends, who prepared the contents in different ways (fried, scalloped, creamed, etc.). In these forms the canned article was highly praised for flavor and palatability. Samples were also sent to several hotels, where the fish was served to the guests as "Japanese halibut," and was pronounced most acceptable. An establishment at Halifax has been canning large quantities and putting them on the market labeled "ocean whitefish." A firm at Charlottetown, Prince Edward Island, has been successful in selling the canned article as "sea bass."

The smooth dogfish found south of Cape Cod is preserved best by salting and drying according to the same method employed for preparing dry salt cod. The product very much resembles cod, but has the advantage of being boneless. I have had creamed salt dogfish served in the mess hall of the Marine Biological Laboratory to a score or more of persons. They all reported that they could detect little or no difference between it and the ordinary salt codfish.

The flesh of the dogfish is apparently just as digestible as that of other fishes, is palatable, nutritious, and easily preserved. The fish are so abundant and easily obtained that they are ridiculously cheap. But prejudice is barring this wholesome food from our menus. People seem more willing to starve than to eat this fish, just because it bears the name "dog." The problem now is how to put the fish on the market without an offensive label and at the same time meet the spirit and letter of our pure-food law.

The packing of both mussels and dogfish ought to become a large industry. Conditions are good for creating a market for them. They are a cheap, wholesome food for the masses and constitute a field of opportunity for the fisherman, the packer, and the merchant.

DISCUSSION.

Dr. OSCAR NORDQVIST. I think that those cheap fishes—for instance, the dogfish and such other kinds as are not used for food—would be a very good food for fish in our hatcheries. I think we could get in that way a cheap food for trout and other fishes in ponds, and I think it would be a good thing; by taking only the more appreciated kinds of fish from the sea and from lakes we disturb the balance in nature and give most chance for those poor fish to increase. And I think it would also be a very good thing for the cultivation of fish in the lakes, for instance, to take away those poor kinds of fish. I think it would be useful for the improvement of the fisheries in the lakes. So I think the more we can use those poor kinds of fish and other species of fish, the better it is for our lakes, and also of course for the sea.

Doctor GILL. I can bear testimony to the edibility of both mussels and dogfish—that is, the common dogfish (*Mustelus*), not that of the northern coast (*Squalus*). We are in the unfortunate position of having the same name for very different animals, unfortunate because of differences of habits of the other fishes of the same name. The word "mussel" in the greater part of this country in the interior is known almost entirely in connection with the species of the enormous family of Unionidæ.

Mr. WHITMAN. When you say that a mussel is a very edible mollusk, some one in the interior will say: "I have tried it. It is the toughest thing I ever attempted to eat, and worthless."

Doctor GILL. So it is; the fresh-water mussel family (Unionidæ) are really worthless; at least it requires a greater power of eating—using the teeth—than I have. But in regard to the mytilids, to which the name "mussel" was originally given, that can not be said.

With regard to the dogfish we have the same dilemma. "Dogfish" is applied in this country to a fish in the interior that is also worthless, having no relationship whatever to the fish that is known as dogfish on our eastern coast, and even the species of our eastern coast have no close relationship to each other. The so-called dogfishes of our eastern coast are as different from each other as a horse from a rhinoceros—in fact, much more so. They belong to an entirely different section of the shark branch. The only similarity is that superficial one resulting from the size and general appearance being about the same, and from the assemblage in schools being about equal. Those are the only points of similarity. They differ entirely in other features; in the dorsal fins and in the anal—one is without that fin while the other has it; the teeth are also entirely different. When we examine the interior we find the differences are really more. There is really no structural similarity, and consequently we are deceived by the similarity of the names. If we could only have different names we might get along a good deal better with the facts.

Now, perhaps you might consider this new name for the dogfish of the south—"mustel." That is not a long name; it is an euphonious name. Call the fish of the northern coast "acanth"—that is not a long name—and perhaps then we would have a solution. The fish would be just as palatable as they are now under the name "whitefish" or "herring" or anything else.

Mr. FRYER. It is quite a poetic idea that the fish culturist should turn the tables on the dogfish and feed other fish on this voracious beast. Much the same idea induced

the fishermen of England to take up the question of putting the dogfish on the market. Three years ago we had in our southern waters quite a plague of dogfish. They approached our shores in unprecedented numbers, and caused very great havoc, not only among the fish, but among the nets; even taking lobster pots and swallowing the lobsters and pots and all, with the result that in sheer desperation the fishermen armed themselves with stronger nets and set out in search of the dogfish and brought him home and put him on the market instead of putting him back again unharmed into the sea. The efforts that were made to open up the markets to this fish have resulted in a considerable amount of success. A great deal of prejudice existed in consequence of the name, the point to which reference has been made. The fish itself came to be known in the northern markets of Lancashire as Darwen salmon. It was rather a slight upon the salmon, I think. Afterwards a prize was offered by the municipality of Plymouth for a name which would be palatable, if I may use the expression, and also for a means of making the fish more palatable, and the name "flake" was pretty largely, at any rate, adopted; but this is not a satisfactory name, and I think the proposal that a euphonious title might be made up out of one of its scientific names—of one of the species of the fish, at any rate—is a very good suggestion, which might be followed up with advantage. In England I suggested the use of the word "tope," which is the Cornish name for one species of dogfish.

As regards its edibility there is no question about its being a good fish. I can vouch for that myself, and I have encouraged a great many people to eat the dogfish, especially immediately after capture. It is very much better than if it has been kept for any length of time.

With regard to the mussel, I know that mussels are edible. I can not vouch for their quality personally so much as I can for the dogfish, because I do not like them, but there can be no question that all the virtues attributed to the mussel as an article of food are justly attributed; and there is, I should imagine, in this country a very large market for mussels, put up in some such way as these before us, at a very low price.

Reference was made to the practice in England of cultivating mussels for food purposes. I think the writer was somewhat misinformed on one or two matters, since he stated that the mussel "lays," as they are called, on which the mussels are placed for fattening purposes, are put in places where they are exposed. Now, the great object is not to expose them—not to place them above low-water mark. We find by experience that mussels that get carried up in the course of nature farthest above low-water mark develop less rapidly and get much more stunted, even when fully grown, than those which are constantly under water, even where all other conditions are similar.

Undoubtedly the brackish waters are, as in the case of the oysters, found to be more favorable for the fattening of the mussel than the very salt waters.

As regards the season: Again, I think a little slip was made, unless the habits of the mussel on this side of the Atlantic differ very much from those on the other, when it was stated that the mussel was in good season for food at the time when the oyster was in closed season or was not good for food. With us the two seasons are practically the same. The spawning season of the mussel is the same as the spawning season of the oyster. I am not sure whether I am rightly informed, but in some of your states I understand there is no closed season for oysters; but with us a closed season is established during what are held to be the most common spawning months, those being the months whose names have no letter "r" in them—after the month of April until you come to September is a closed time both for mussels and for oysters as well.

I heartily indorse from my own experience on the other side the suggestion that steps should be taken to encourage the development of fisheries for both these products; the one because it is an undoubted nuisance and for the further reason that while we are reducing the numbers of what are known as edible fish we are altering the balance of nature and leaving the dogfish unattended to. Of course in this country I need not,

I think, refer to the possibilities of the dogfish as a producer of oil and manure. I imagine that already the fish is used in those directions. The paper is limited to the question as to its use for food.

One little matter in regard to the mussels occurs to me: It is very easy indeed once an industry is established for bringing the mussels to market, to fish out natural beds, or scalps, as they are called in England; and I would recommend that if this question is taken up—the question of developing the trade by opening up the markets—the other side of the question should be dealt with at the same time and precautions taken against the possible depletion of the natural beds.

Mr. T. E. LIBBY (Maine). I just want to say a word in regard to the dogfish, for the simple reason that it is the most destructive thing to the fisheries that I know of. It is an international question, as all those familiar with it know that there is no fish along the Atlantic and Canadian shores that is so destructive to the fisheries, especially for the ground fish. As I understand from United States Fish Commissioner Bowers, there was a bill introduced in Congress appropriating \$25,000 to see what could be done in regard to the dogfish—the best way to utilize it. This bill, as I understand, has got no further. There have been also bills introduced in the Massachusetts legislature, but nothing has come from that; I am pleased to state, however, that I understand, and we will no doubt hear from Professor Prince, that the Canadian government has been doing and is doing to-day something in regard to the extermination of the dogfish, not making it an article of food, but using it for the oil and as a fertilizer. I think that the dogfish as found along the southern shores is much different from the one found on the northern shores, for the reason that it has a smooth skin and the one on the northern shores is of a rough skin. I know I have seen some of those cured myself, and the northern dogfish when cured is very white at first; inside of a month, however, it will turn a yellowish cast, and I have seen efforts to put it on the market, but these were unsuccessful, because of its turning in color. The dogfish in the north has a very large liver, which of course makes it produce a very large amount of oil. For this reason the oil is all through the meat and causes it to turn.

This is a very important question, and I hope there will be some resolutions introduced in this congress encouraging the passing of some bill by the National Congress for the extermination of the dogfish.

Mr. FRYER. I do not want to become a dogfish and monopolize the conversation, but the remark Mr. Libby was good enough to make to me just now that the dogfish is used for the purpose of oil reminds me that experiments have been made in England with the eggs of the dogfish, with the result that in an immature state they have been declared to contain constituents almost exactly similar to those of hen's eggs, and to be extremely nutritious. The only thing against them is their flavor; but following that up, further experiments have shown that the eggs can be used for the production of a very high class of medicinal oil. I think that the suggestion might possibly be of practical advantage if it were made known.

Doctor GILL. What dogfish do you mean?

Mr. FRYER. The dogfish known as "rough hound." I forget the scientific name for the moment.

Doctor GILL. Yes, you mean sharks of the family of scylliorhinids; they differ very greatly from the dogfishes of our coast; they lay eggs inclosed in cases, whereas the piked dogfish or acanth, as well as the smooth dogfish, or mustel, do not hatch eggs at all externally; in fact they are viviparous.

Mr. FRYER. It is the *Squalus catulus* I am speaking of.

Doctor GILL. A scylliorhinid.

The PRESIDENT. It may be that another possible use for the eggs of the dogfish would be for the purpose of producing albumen for preparing photographic films. That only occurred to me at this moment.

Mr. FRYER. I doubt if there is very much albumen in them; they are chiefly oil.

The PRESIDENT. I am glad to be corrected. I think Mr. Atkins was about to speak.

Mr. C. G. ATKINS. I have not a great deal to say, Mr. President, but having tried the flavor of these various things that have been spoken of, I would like to say that I found personally the flavor of the dogfish was agreeable to me, and the flavor of the salt-water mussel, but that fresh-water mussel was very disagreeable.

As to Doctor Nordqvist's suggestion that we make use of the dogfish and other refuse sea fishes for feeding fish, I have been for several seasons trying to induce the fishermen to sell it for that purpose—to bring the dogfish in—but I got very few from them. I propose to carry the matter further and try to get quite a supply of them; in fact, to try them further for feeding salmonoid fishes. They are very numerous in my vicinity. Late in the summer they become a dreadful pest in all the fisheries—haddock, cod, and all those other fisheries along the coast.

Mr. JOHN J. PEW. I have tried dogfish where it has been tinned—I understood the northern dogfish. We had some tried in our office, which were sent us to see what it would be worth for mercantile purposes. We tried the flavor and to keep them in the can awhile. The color was disagreeable, not taking at all, and the flavor was not very acceptable to any of us, and we thought it was a waste of time and money to try to put them to use in our trade. We concluded the best method was to destroy them and use what we have on our coast for oil and fertilizer purposes.

Professor PRINCE. I do not want to inflict myself too much on the congress, but the subject which was brought up before us in the very excellent paper by Doctor Field has a great personal interest to me.

The first official work I ever did in fisheries was on a mussel commission in the old country, and I happened to be secretary of that commission. We went very fully into the uses of the mussel, and in our report published a number of interesting facts. One was the enormous amount of mussels annually consumed in London and other English cities as food. The amount was appalling, 10,000 tons per annum in London, if I remember correctly. Then we found that there was a very large amount used for bait by the long-line fishermen. They relied upon the mussel as their principal bait, and such a demand was there for these mussels for bait that British supplies were insufficient and mussels were imported from Holland, where mussel cultivation has been carried on to a very large extent; and I am only sorry that Doctor Hoek is not present, because he has a very thorough knowledge of what has been done in the Netherlands in the matter of mussel cultivation. The Dutch have gained wealth from their mussel beds. They export very largely to Scotland, because the Scottish beds were not large enough to supply the demand.

Personally, I have very pleasant recollection of mussels from my early days. By most people in England the mussel was considered rather a delicate morsel. I remember as a boy going to bed after a supper of mussels, and I sometimes feared the consequences, but I do not think I ever suffered harm. There is a large amount of hepatic matter in the mussel, the liver being very large indeed; but, at any rate, it is a most excellent and succulent mollusk, and it is astonishing that it has not been more utilized on this continent for the two purposes which have been mentioned, namely, bait and food.

Perhaps we ought to be cautious in recommending the use generally, without some tests being made. I may be wrong, but I have some recollection that when Captain Cook navigated the Pacific coast some of his crew went ashore and ate mussels, and I think one of the men died. That may have been due to the fact that it was not properly a mussel, but I know on some parts of the Canadian coast the mussels are not quite equal to the mussels of Europe. The matter is one that can well be looked into.

The dogfish question is one which has very seriously occupied the Canadian government. The dogfish have been for eight years or more a perfect pest on the Atlantic coast especially. They have been very numerous on the Pacific coast, and on the Pacific coast they were turned to account in the manufacture of oil, in the vicinity of Queen Charlotte Islands, but the carcasses were thrown away. In Canada the proposition was made that they should be utilized in some way or other. My own original proposition to the government was that we should adopt some method of extermination, without any idea of utilization, as Australia dealt with the rabbit pest on land. I favored methods of extermination, to get rid of the pest as soon as possible.

Another scheme, for which I am to a large extent responsible, was dogfish reduction factories for grinding up these fish into fertilizer materials. But the oil in the tissues was a very great trouble; there seemed to be too much oil to get rid of; but a very good fertilizer material was produced by three large government fertilizer works. Doctor Field, of Boston, will be able to tell us something about that. He has just visited these works. They are using a large number of these dogfish for purposes of fertilizer, and the government has spent a large sum annually on reduction works; but these factories have not done anything in regard to utilizing them as food. The three works at Shippegan, Chaleurs Bay, Canso, Nova Scotia, and Clarke's Harbor, western Nova Scotia, have all utilized the dogfish for fertilizer, and the supply of that fish was often far larger than the works could possibly handle. These enterprises encourage the destruction of the dogfish; and I believe the last reports regarding the dogfish indicate they are not so plentiful. If Mr. E. C. Whitman, of Canso, is present he might tell us something about the dogfish on the Nova Scotia coast at the present moment.

With respect to their use as food, I recommended to the Dominion Government that a bounty be given, in order to bring "ocean whitefish," as canned dogfish has been called, upon the market, but as they had to be placed upon the English markets at a very low price, in order to compete with salmon and other cheap canned fish, our Government did not see its way clear to bonus this enterprise. I requested this because I am satisfied that if the canned dogfish, properly put up, once gained any hold in the markets—the great markets of populous countries—the demand would be assured for the future. It is a most excellent food, and while Mr. Libby said—at least one of the gentlemen present told us—that the appearance of the fish deteriorated by keeping, so far as I know the dogfish which were canned in Cape Breton and Canada as an experiment had a very good appearance a long time after they had been put up. I have some of them in my office at present, and upon opening them at least a year after packing the color had not much deteriorated.

There are really a great many things to say about this question. Now, the wharves and floors of the reduction works at Canso at times were just covered with dogfish eggs nearly as large as hen's eggs, and they certainly could be turned to account. In Norway they have been used for a century or more for domestic consumption; women collect them and make puddings of them. I do not think they are good boiled or poached, but they are suitable for puddings.

There is another point that I have often referred to, in regard to this dogfish question—so serious a question for our fisheries. It is this: That the fishermen should be discouraged on all hands from simply opening the female fish full of living young and liberating them in the sea, as they have constantly done. I have been on boats when the men just did this in order to see the young dogfish swim away, which is a kind of artificial fish culture that we ought to deprecate in the strongest terms.

The PRESIDENT. Do you desire to have the discussion still continued? I wonder if any serious effort has been made to use the skin of the dogfish for leather?

Dr. GEORGE W. FIELD. The fish commission of Massachusetts had this dogfish matter placed before them for the first time about three or four years ago. They have

instituted various inquiries and experiments, and, among them, the question of the possible utilization of the skin. The chief difficulty appears to be in getting the skin off, but when it was once taken off and tanned it makes a very satisfactory leather for use on sword hilts and pocketbooks. It is a very delicate and rough leather, not unlike lizard skin, so much in vogue for certain ornamental articles.

In regard to the use of the dogfish as food, we have had some practical experience. We served the dogfish to the Biological Club, together with halibut, and students accustomed to make observations were unable to taste the difference, and claimed that it was equally good.

On the other hand, the practical packers are up against a very grave difficulty. They put this dogfish in competition with salmon, and they found very great difficulty in getting an adequate supply of the dogfish. The supply was intermittent; they would get one day more than they could handle, and then the factory would be obliged to remain idle a week, a month, or perhaps longer. So that in utilizing the dogfish it seems to me that the question of a definite supply to the factories in whatever way they are utilized is the most important one.

The Massachusetts Commission of Fisheries and Game has taken up the question of determining the valuable content of these fish. They are determining the amount of oil in the liver, in the flesh, and in the egg; how much glue there is in the skin and head and fins; whether the fins may not be utilized as they are in China and Japan for making a material for soup; whether the skins can not be utilized as leather, or some method devised by which they may be utilized more cheaply. In other words, we are trying to get a scientific basis by which the manufacturer can be in a better position to know exactly what he can do with the raw material, in order that we may say to the manufacturer, "Your process is deficient in this point or the other, and there is an opportunity for you to get better returns than you are securing at present." We are also going to attempt the consideration of the question whether there may not be devised some better method of securing a permanent supply of these dogfish to the various factories where they may be utilized, and the possibility of running a vessel about among the fishing fleet, where the dogfish may be collected and brought to the factories. We have in Massachusetts a considerable number of factories and fertilizer works where fish scrap is made, and those factories may use it to a certain extent if we can find some way by which the fishermen can be induced to bring the fish in. At present there is a tremendous prejudice against the dogfish. They are an ugly fish to handle; are a difficult fish to get off the hook if you attempt to bring them into the boat, and the only successful method is to bring them onto the edge of the boat and slap them off. The factories in one section object to handling them, whereas in Canada they are able to get all the dogfish they can handle at times at \$4 or \$5 a ton, and it is a question whether the fishermen in Massachusetts, who deal in the fresh fish and run the largest possible quantity of fresh fish in the least possible time to the Boston market, would care to take it up from the same point of view that the Canadian fishermen do.

There are a number of practical questions that we hope to have light on at a later time.

Mr. HATHAWAY. I will say a word on just one point that Doctor Field called to mind, in relation to an experiment made by the Fisheries Commission, to which I made reference here on Tuesday and which was conducted under my observation. One of the steamers that had been used in menhaden fishing was rigged up with an ocean overdraft, for the purpose of experimenting and seeing how the seine would work. We took the steamer at Timothy, R. I., and began operations just before sunset off 10 miles to the south of Marthas Vineyard Island. We made one haul and caught some 20 or 30 bushels of dogfish, a great variety of other fish, but none of any particular amount or value. We ran down the coast that night near to Shinnecock, Long Island, and began the next morning at daylight operating up toward Block Island. We cast a seine

some half dozen times that day, I should say, and at each haul got quite a number of dogfish, together with other fish, but no other fish in any quantity. About 2 or 3 o'clock in the afternoon, when fishing in water somewhere near 20 fathoms deep and about 10 miles to the south of Block Island, we made a big haul, and I am satisfied that that twenty-four hours' operation landed some 12 or 15 tons of smooth dogfish; so I have no doubt in the world that they can be taken in that way to great advantage. We were not able to use these fish as fertilizer, because the nearest factory to the point of operation was some 200 miles and under the conditions then existing these fish could not be run through the menhaden cookers, the knives being too small. Of course that could be easily remedied, and I understand has been remedied in the Canadian factories. If those fish could be used or had any value at all, I have no doubt in the world that in the deep-sea trawl fishing along the coast from Shinnecock to Sandy Hook, where my experience lay, dogfish could be caught in quantities and sufficient to make it a commercial value to the fishermen.

As to the edibility of the dogfish: They have been eaten for years and years along part of our southern coast, particularly in the lower Chesapeake Bay, from which I originally came; and it is said that they have been used in connection with crab meat, which is so abundantly put up.

The mussel is very abundant along the coast, and I two years ago purchased from a fisherman, to be used for fertilizer—for manure—a thousand bushels for \$50. He landed them on the wharf at the farm lot in Little Egg Harbor, near New Gretna, New Jersey. Now, those mussels were opened up by this fisherman, giving him sufficient wages to live, for 5 cents a bushel. All along the coast, from Cape May to the Maine coast, they are very abundant. They are not very abundant below Cape May.

Mr. WHITMAN. Reference has been made to government dogfish reduction works at Canso, Nova Scotia, and as I have just come from there it may be interesting for you to know that those works are now taking in all they can handle each day. The works have a capacity of 25 tons of dogfish a day, and if they had a capacity of 500 tons a day there would be no trouble to supply them. Just at this season the dogfish are very abundant, and I recently saw one vessel bring in 50 tons, which would of course supply the works for two days. But they are making no use of them except to extract the oil and convert the residue into fertilizer. This has been going on for the past three years, since the Canadian government decided upon this method of dealing with the dogfish pest. It is not a commercial success. The government always pays out more money than it receives, but that is chiefly because the operating season is so short. The works operate only some two months of the year, and the fishermen will not catch dogfish at \$4 a ton if they can get more profitable fishing to do. It is only when the dogfish become so plentiful that they can not carry on regular fishing for food fish that the fishermen turn their attention to the dogfish.

The oil is of superior quality, and both the oil and the fertilizer find ready sale. The fertilizer up to this time has been marketed in New York at \$35 a ton. The oil sells for 30 cents a gallon. Experiments are now being made to see if other products can be taken from this fish, such as glue and isinglass; and if the skins can be used as Mr. Field has suggested, that will be good, but up to this time they have been treated only for the oil and fertilizer.

The PRESIDENT. Shall we close the discussion?

Dr. GEORGE W. FIELD. As Professor Prince has said, we visited last month three factories, to which Mr. Whitman has referred, and we got statements in regard to the amount of dogfish they had destroyed at two of these works. We made a rough estimate, and we figured that those two factories had destroyed about one-fourth of what the entire Massachusetts fleet catch in one year. We figure the Massachusetts catch at about 27,000,000 dogfish a year; and we found that about 7,000,000 dogfish were de-

stroyed, i. e., turned into fish scrap, at these two factories during the time they were running.

Mr. WHITMAN. It might be of interest for you to know that the steam trawler that was brought over from England to operate on our Nova Scotia coast in one hour recently filled her trawl net so full with dogfish that it parted the lines, and carried the net away. The captain estimated more than 15 tons of dogfish in the net. He says that he usually avoids the places where dogfish are. He knows them by the oil on the surface of the water. But this time the net was cast in the wrong place and in a few minutes it had filled so full that the weight carried the net away.

Doctor GILL. I think that Doctor Field of Woods Hole labors under some misapprehension as to the clam. He remarked, if I understood him rightly, that the clam was not esteemed in England. They have no clams, in our sense of the word, in England. The family of venerids is represented by only two small species of no economic value, their place being taken economically by the cockles or cardiiids. By a curious coincidence, the name "clam" is in very little use in England, and what they call a clam is not like our hard clam at all. It is a very interesting fact that we derive the name clam from England, but we apply it in a very different way from what it is applied in England. Of course, I can not go into the full history. Suffice it to say that the word "clam" in England is mostly applied to the piddock—that is, to a species of the family of pholadids.

Dr. IRVING A. FIELD. In reply to Doctor Gill's criticism, I want to say that it is not from personal experience that I speak about the clam of Europe; that is a quotation from Ganong's *Economic Molluska of Acadia*, in which he states that the soft-shell clam occurs in Europe, but is not used. He calls it the soft-shell clam.

In regard to the poison mussel: There are cases of mussel poisoning on record. There are also cases of poisoning from clams, from lobsters, from crabs, and other animals in that group. I wish to state, however, that there are no cases on record of poison from mussels that were collected from what might be called pure water, in good circulation. The most notable cases of mussel poisoning on record are those which occurred at Wilhelmshaven, Germany, in the early eighties, and in these cases it was found that the mussels came from stagnant water. These mussels, which were very poisonous, when placed in free-circulating water became harmless in about two weeks. On the other hand good mussels placed in the impure water became poisonous. We may say, therefore, that poisonous mussels come from poisonous water. These results were obtained by Virchow and also by Wolff in 1886.

Doctor GILL. You have found persons pretty generally prejudiced against mussels?

Dr. IRVING A. FIELD. Yes; for that reason.

Then as to the season for mussels, I wish to say again that I was right when I said that the mussel is in season when the oyster is out of season, for the mussel is the very best to eat during the breeding season, or just prior to the breeding season. After the breeding season the mantles become very thin and there is very little meat to the mussel at all.

I stated in my paper that they breed at a prolific rate. I have not been able to locate the center of the reproductive gland. In fact the whole animal is a reproductive gland at the height of the breeding season. If you take a mussel in June or July you will find the reproductive organs covering the floor of the body, filling the mantles full and extending over the liver, so that the whole mussel appears to be a great reproductive gland. Eggs, of course, are very nutritious, and it is at this period we find the mussel containing about 18 percent of protein. In September and October, or the latter part of August, September and October, when the sexual products are liberated, mussels lose probably two-thirds or three-fourths of their weight, become very thin and shrivel up, so that when cooked they are no larger than the end of one's little finger.

Now, coming to the dogfish, I think it was Mr. Libby who said there was trouble in dry-salting northern dogfish, which at first are white and nice but later become brownish

and very disagreeable in appearance. I have had that experience myself. It becomes the most nasty-looking stuff, covered with a brown, gelatinous substance; but I have found that if you keep the dogfish in a brine they will remain white for an indefinite period. I have some two years old in good condition. You can take them out of the brine and soak them for a few hours before cooking. If put on the market in brine they can be made a good food product, and persons can keep them at their homes a week or two before they will turn brown.

The dogfish may be of economic value from the standpoint of the production of gelatine. There is a very high percentage of gelatine in the flesh of dogfish, and when extracted it comes out beautifully clear and white, and apparently needs no refinement, the only objection to it being that it has a fishy flavor. I think possibly Doctor Alsberg, the chemist at Woods Hole, will be able to tell us a great deal about this in a short time.

Doctor GILL. That is quite right about the clams along this coast, south of Cape Cod. The common or hard clam is the *Venus mercenaria*, a representative of the family of venerids; the clam along the north coast, or soft clam, is the *Mya arenaria*, a species of the family of myids.